

- Fig. 58. *Tylocephalum ludificans*, sp. n. *Type*. Section through an example in the tissues of the Ceylon Pearl-Oyster in Professor Herdman's collection. Slide 94 of Professor Herdman's series. *a.*, armature of collar. This shows the myzorhynchus of "*Tylocephalum*" form, due to the posterior face (*m.p.*) being contracted and its surface thrown into folds and the anterior face (*m.a.*) stretched. Compare the adult *Tylocephala* in figs 61 & 62, and also the species shown in fig. 65.  $\times 70$ .
- Fig. 59. Section through another example of the same species, showing the "*Cephalobothrium*"-form of myzorhynchus; here the posterior surface of the myzorhynchus (*m.p.*) is tense, and its anterior surface (*m.a.*) is thrown into folds. *a.*, armature of collar. (Compare the adult worm in fig. 66.)  $\times 70$ .
- Fig. 60. An adult worm, which may be the adult of *Tylocephalum ludificans*, from the spiral intestine of *Aëtobatis narinari*.  $\times 6$ . From Dr. Shipley's collection.

## PLATE XLVII.

- Fig. 61. The head of the worm shown in fig. 60, viewed as a transparent object. *m.*, myzorhynchus; *s*, *s'*, *s''*, three of the four marginal suckers; *a.*, armature of collar; *seg.*, first proglottides.  $\times 70$ .
- Fig. 62. The same, in section; letters as above.  $\times 70$ .
- Fig. 63. Armature of collar of same, about point *a* in fig. 62.  $\times 1000$ .
- Fig. 64. Penultimate segment of same.
- Fig. 65. Head of *Tylocephalum uarnak* from *Trygon uarnak*. From a slide in Dr. Shipley's collection. *my.*, myzorhynchus, which here is fully protruded; *ma.*, anterior face of same; *mp.*, posterior face; *s*, *s'*, *s''*, *s'''*, the four marginal suckers.  $\times 45$ .
- Fig. 66. Head of *Cephalobothrium aëtobatides* from *Aëtobatis narinari*. From a specimen in Dr. Shipley's collection. Letters as above.  $\times 70$ .

# 19. Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss., and the Description of a new Genus. By ROBERT SHELFORD, M.A., F.Z.S.

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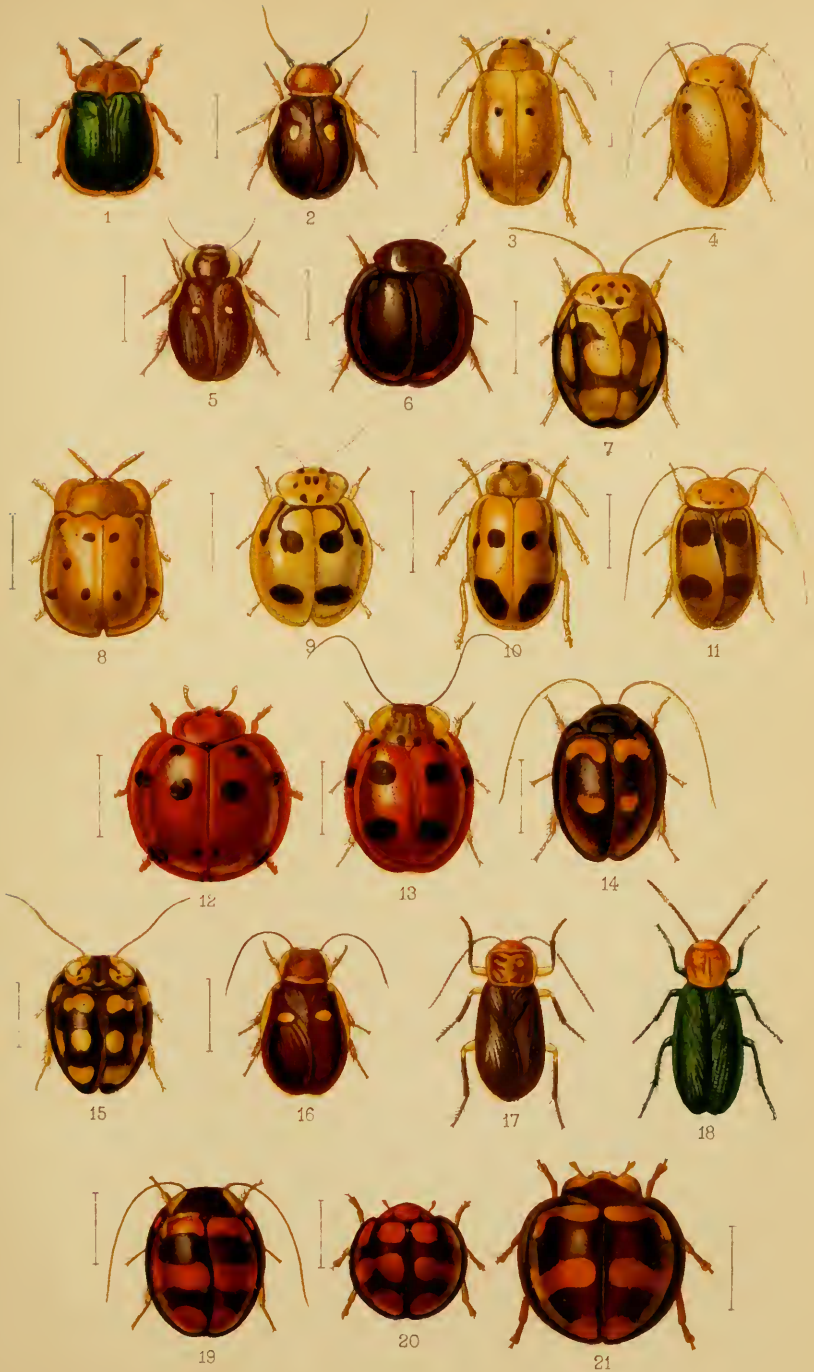
(Plate XLVIII.\* and Text-figures 42-46.)

Speaking in general terms the Blattidæ may be regarded as a somewhat defenceless group of insects, preyed upon by numerous enemies both vertebrate and invertebrate, to escape which they must rely on their skulking, cryptic habits, and on a high degree of speed when disturbed. In accordance with their cryptic mode of life most cockroaches are obscurely coloured, harmonising more or less perfectly with their inanimate surroundings, or, at any rate, displaying no conspicuous markings to attract the attention of potential foes.

Exceptions to this cryptically coloured type of cockroach, however, exist in some numbers and are dealt with in the following pages.

The Australian continent is the headquarters of a group of Blattidæ which presents all the features customarily associated with extreme unpalatability. This group is the *Polyzosteria* section of the sub-family Blattinæ. Nearly all the species are apterous and expose themselves freely, and many are endowed with a most repulsive odour. Mr. W. W. Froggatt informs me that *Polyzosteria limbata* Burm., *P. cuprea* Sauss., and others of this

\* For explanation of the Plate see p. 376.



Horace Knight del. et lith.

West, Newman chromo.

MIMETIC COCKROACHES AND BEETLE MODELS.

genus and of *Platyzosteria* Br., are fond of sunning themselves on the tops of posts and tree-stumps. Commander J. J. Walker when collecting in Australia frequently encountered a species, *Cosmozosteria lateralis* Walk., which emitted so vile a smell that he always refrained from touching it. This species is russet-brown in colour with some variable yellow markings on the thoracic and abdominal tergites, and on each posterior angle of the ninth abdominal tergite is a brilliant orange-red spot; when the insect is at rest these two spots are almost concealed, the ninth tergite being somewhat retracted within the preceding one, but on the approach of an enemy the apex of the abdomen is elevated and slightly distended so that the orange spots become conspicuously displayed to view. A better example of a warning signal associated with highly distasteful properties could not be found.

Prof. Baldwin Spencer, writing in 'Nature' of July 28, 1892, p. 309, says:—"One morning, when Mr. Frank Connelly and myself were digging for worms, we accidentally cut in two a cockroach. From between the segments in its back it poured forth a milky-white fluid, possessing an odour so execrable and pungent that it drove us from the spot." It is unfortunate that the species was not identified, but I expect that it was one of the *Polyzosteria* group.

Commander J. J. Walker says of *Periplaneta fortipes* Walk., a synonym of *Platyzosteria novæ-zealandiæ* Br., that it is "very evil-smelling," but that its smell "is quite mild in comparison with several of the Australian species." (Entom. Monthly Mag. (2) xv. p. 70 (1904).)

Dr. G. B. Longstaff recently took this species in some numbers in New Zealand, finding it, however, not in exposed situations, but under logs and the bark of dead trees. Quoting from his notebook Dr. Longstaff tells me that one specimen had a "moderate cockroach odour, evanescent," of another that it had "a strong peculiar fætor." The discrepancy may possibly be accounted for by sexual differences (see remarks later on *Eurycotis floridana* Walk.).

All the Australasian species of the *Polyzosteria* section appear to be conspicuous insects. Many of them are shining black, a colour which is noticeable enough in Nature when associated with free exposure; others are black edged with yellow, or with red legs. The species of *Anamesia* Tepp., are chestnut-brown banded or margined with yellow. *Cosmozosteria zonata* Walk., is black, banded with yellow or orange. Many of the species of *Polyzosteria* Burm. are bright with metallic colours, and *Euzosteria mitchelli* Angus, with its bronzy dorsal surface, spotted and barred with orange or yellow, its pale yellow ventral surface and sky-blue tibiæ, is the most gaudy cockroach yet discovered. In the New World the *Polyzosteria* section of the Blattinæ is represented by the genera *Eurycotis* Stål, and *Pelmatozilpha* Dohrn. The species do not appear to be so blatantly conspicuous as their Australian relatives, but it seems likely that most, if not

all of them, are endowed with very distasteful properties. Rehn and Hebard (Proc. Acad. Nat. Sci. Philadelphia, 1905, p. 32) write of *Eurycotis floridana* Walk. :—"When seized these insects emit a vile-smelling oily fluid. The females always produced far more of this than the males." This is a chestnut-brown species, but the larvæ have the thoracic tergites margined with pale yellow; it is found hiding under logs and stones. It is evident, then, that amongst the Blattidæ a nauseous odour or taste is not invariably associated with aposematic habits,—the insects themselves may be conspicuous enough when unearthed from their hiding-places, but the point is, that they do not voluntarily expose themselves, as do so many of the Australian *Polyzosteriæ*. Further confirmation of these rather puzzling facts is afforded by observations made by Mr. G. A. K. Marshall on two South-African cockroaches, *Deropeltis erythrocephala* Fab. and *Aptera fusca* Thunb. The first of these belongs to the subfamily Blattinæ and to a genus in which the males are winged and the females apterous. In both sexes the posterior margin of the fifth abdominal tergite is sinuate \*, and beneath the tergite are situated glands from which a sticky fluid exudes when the insects are seized. Though it is reasonable to suppose that this fluid is a distasteful secretion of a defensive nature, it must again be noted that *D. erythrocephala* and probably most of the other species of the genus hide beneath stones and do not expose themselves voluntarily. Most of the species of *Deropeltis* are bulky insects, piceous in colour; in *D. erythrocephala* the head and legs are red. *D. dichroa* Gerst., from the Gold Coast, has a large fulvous macula on each side of the sixth and seventh abdominal tergites; whilst *D. paulinoi* Bol., from Angola, is equally conspicuously marked with rufous fasciæ on the lateral margins of the pronotum. The female of *Aptera fusca*, one of the Perisphæriinæ, is a large, robust insect, piceous with conspicuous transverse bands of ochreous or rufous; when seized it exudes a violet fluid which stains the fingers; this species also has cryptic habits. This is absolutely all the information that I have been able to gather about unpalatable species of Blattidæ, and it certainly is little enough. It is perhaps remarkable that the undoubtedly nauseous Australian species are not mimicked either by other orders of insects or by non-distasteful species of Blattidæ, but it must be remembered that the Orthoptera do not serve as models to other orders of insects—not a single instance has ever been recorded, and in Australia the paucity of cockroaches other than those of the distasteful group, is quite exceptional.

Although no Blattidæ are known to serve as models to mimicking insects, there are several which mimic insects other than Orthoptera, though in most instances the mimicry is of a very generalised nature. I have no reason to suppose that any of these mimetic Blattidæ are other than palatable.

\* A generic character.



In a very superficial sort of way cockroaches and beetles may be said to be similarly constructed. In both the pronotum is large whilst the other thoracic tergites (in the winged species) are concealed; in both the membranous wings are covered by elytra or tegmina of a coriaceous or corneous texture. In fact only a slight modification of the cockroach-form is required to produce a distinctly Coleopterous appearance. The names *lycoides*, *buprestoides*, *coccinelloides*, *dytiscoides*, *silphoides*, given to species of Blattidæ by various authors, are sufficient evidence of their resemblance to beetles. It is quite an open question whether this generalised resemblance of certain Blattidæ to Coleoptera can be legitimately classified under the heading of Mimicry. It could well be argued that some of the species, at any rate, owe their beetle-like form to convergence in development, or, to use Sir Ray Lankester's term, that cockroaches and beetles are homoplastic forms. On the other hand, as will be seen later, some of the cases of resemblance are so detailed and close that it is impossible to regard them as anything but examples of true mimicry, and it becomes most difficult to draw the line between the two classes of resemblance. For convenience' sake, at any rate, throughout this paper the Blattidæ which resemble insects of other orders will be termed "mimics."

Examples of generalised mimics of the Coleoptera are furnished by species of *Pachnepteryx* Br., *Caloblatta* Sauss., *Paratropes* Serv., *Phoraspis* Serv., *Eustegasta* Gerst., *Achroblatta* Sauss., *Corydia* Serv., *Areolaria* Br., and *Hypnorna* Stål, whilst several species in other less specialised genera might be quoted. Of not one of these species can it be said that it is very like any definite species of beetle. *Eustegasta buprestoides* Walk., from West Africa, is a metallic green cockroach with round yellow spots on the tegmina, and as its name implies, it is very like a Buprestid beetle. But in spite of the most diligent search amongst collections of Buprestidæ, I have never found a species which by the greatest stretch of imagination could be regarded as even an indifferent model for the cockroach.

Belt speaks of mimetic cockroaches in 'The Naturalist in Nicaragua' as follows:—"The phosphorescent species of Lampyridæ, the fireflies, so numerous in Tropical America, are equally\* distasteful, and are also much mimicked by other insects. I found different species of cockroaches so much like them in shape and colour that they could not be distinguished without examination. These cockroaches, instead of hiding in crevices and under logs like their brethren, rest during the day exposed on the surface of leaves, in the same manner as the fireflies they mimic"†. It was with much interest that I found in the Hope Museum, Oxford, a specimen of the cockroach *Achroblatta luteola* Blanch., with the following note in

\* I. e. with the non-phosphorescent species, by which Belt appears to mean the beetles now known as Lycidæ.

† I quote from the Everyman's Library Edition (Dent & Sons, 1911), p. 243.

Westwood's handwriting attached to it:—"This *Blatta* lives on trees and closely resembles in its habits some of the large Lampyridæ [T. Belt]." This is doubtless one of the species mentioned by Belt in his book, and I had great hopes of being able to match it with a definite species of Lampyrid beetle, but the most diligent search through the Godman-Salvin collections of Central American insects failed to reveal a "model" to the cockroach. The Malaco-dermatous appearance is undoubtedly but generalised, not specific. The same may be said of *Hyphorma amœna* Sauss. & Z., also from Central America. This Blattid has all the appearance of a small Longicorn, but it actually resembles no particular species of that family. It may, of course, be argued that further collecting will bring to light species of beetles which can legitimately be regarded as models to the cockroaches, but I do not think that this is in the least degree probable. Our knowledge of the Central American Coleoptera must now be nearly complete, speaking from the point of view of the systematist, and the West African *Eustegasta biprestoides* is so very abundant that it might reasonably be expected that its supposed model would be, if not abundant, at any rate in sufficient numbers to permit of some specimens falling into the hands of collectors. At the very end of this paper I describe two new species of Blattidæ, belonging to a new genus, which also must fall into the category of generalised Coleopterous mimics.

The two species of the Oriental genus *Thyrsochera* Burm. are shining black cockroaches with large yellow spots on the tegmina, a type of coloration frequently met with amongst the Endomychidæ of the same region. These cockroaches, though far larger than, and in other points quite unlike any Endomychidæ known to science, may possibly be regarded as part of a "convergent group," the dominant or "central" members of which are the yellow-spotted Endomychidæ (genus *Eumorphus*). A generalised resemblance to certain families of Rhynchota is also shown by some Blattidæ. For example, some species of *Holocompsa* Burm. and *Hypercompsa fieberi* Br. are rather like small Capsidæ; the illusory effect is produced by the tegmina, which are largely membranous and hyaline, though opaque and coriaceous at the base; the resemblance does not bear a very close examination. *Homopteroidea nigra* Shelf. is not unlike some small Fulgorid or Jassid. Mr. J. C. Kershaw found at Hong-Kong, under a stone, several little black Pentatomids, and in company with these a similarly coloured and shaped cockroach which appears to be identical with *Pseudophyllodromia parilis* Walk., and he suggested\* that the cockroach mimics the bug. Having seen the specimens I prefer to regard them as examples of synecryptism or of homoplasy.

Linnæus, deceived by the Coleopterous appearance of *Corydia petiverana*, placed it in his genus *Cassida*. Mr. T. Bainbrigge

\* In a letter to Professor Poulton.

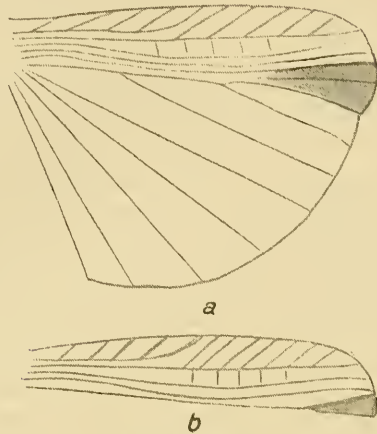
Fletcher, who has watched this insect in a state of nature in Ceylon, tells me that when it is flying it looks very like a conspicuous Agaristid moth, *Mimeusemia ceylonica* Hmps. The resemblance is certainly not very striking when the dried insects are seen side by side in a cabinet, but no field-naturalist will attach very much importance to that, and in any case Mr. Fletcher does not maintain that the resemblance is detailed and accurate, but merely generalised.

The power which the females of species of *Perisphaeria* and *Pseudoglomeris* have of rolling themselves up into spherical balls when alarmed is well known, and on account of their convex form and black shining colour, they undoubtedly bear an extremely close resemblance to the pill-millipedes which are so abundant in the tropics. But here again I doubt if any particular species of millipedes are copied. It is certainly a fact that whilst two species of *Perisphaeria* were not infrequently met with in Sarawak, both rather small, black species, I never once found a millipede corresponding in size or colour to them. It is by no means certain that the pill-millipedes are distasteful animals—on the contrary, it is quite probable that they are palatable but well protected by their hard integuments and power of rolling up into a ball. The same habit is shown by many terrestrial Isopoda, but no one considers that the Isopods mimic the Millipedes or the Millipedes the Isopods. The similarity of habit and form is attributed to homoplasy, and I see no reason why the same habit of the cockroaches should not also have been quite independently evolved.

Having now passed in rapid review the principal genera of Blattidæ which show a more or less generalised resemblance to insects of other orders, it only remains to consider in greater detail the genus *Prosoplecta* Sauss., nearly all the members of which present a remarkably close and detailed resemblance to definite specific models amongst the Coleoptera, so far as these have been discovered. With but two exceptions the species of *Prosoplecta* present an appearance which is conveniently summarised as Coccinelliform; that is to say, the outline of the body is oval verging on spherical, the form is markedly convex, the integuments are smooth and nitid, the tegmina are corneous with obsolescent venation and do not extend beyond the apex of the abdomen, the legs and antennæ are short and, finally, the insects are gaily coloured. It is scarcely necessary to point out that the Coccinelliform type is found amongst other families of Coleoptera besides the Coccinellidæ; it is found, for example, amongst the Cassididæ, Chrysomelidæ, and Galericidæ, whilst many of the Scutelleridæ, a family of Hemiptera, also present much the same facies. The two species, *P. coccinella* Sauss. and *P. bipunctata* Br., are, in spite of the name of the first, far less Coccinelliform than the other species of the genus, and may certainly be regarded as more primitive. The form is more depressed, and I am inclined to suppose that these two species,

though distinctly Coleopterous in appearance, fall into the category of generalised beetle-mimics.

Text-fig. 42.



*Hemithyrlocera* sp.

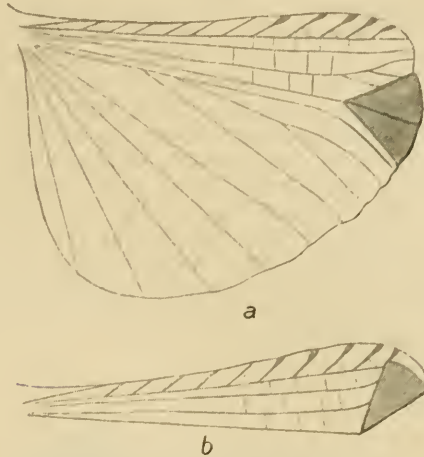
Wing expanded (a) and folded (b). The apical triangle is shaded.

In the genus *Prosoplecta* the wings have been modified in a very remarkable manner, and as their structure has never been properly described and is of particular interest when considered together with the mimetic resemblances of the genus, it is necessary to go now into some details of the cockroach wing-structure. The wing of a cockroach such as *Blattella germanica* L., is divided longitudinally into an anterior and a posterior part; the anterior part is more or less rigid, being strengthened by numerous longitudinal and transverse veins, while the larger posterior part is supplied only with radiating longitudinal veins. When the wing is closed the posterior part shuts up like a fan and folds underneath the anterior part, which remains stiff and unfolded. At the apex of the line of division between the anterior and posterior parts of the wing is a quite inconspicuous area which, when the wing is closed, appears as a minute fold lying on the top of the anterior part. This insignificant area, which belongs neither to the anterior nor to the posterior part of the wing, is the forerunner of a part of the wing, which in some genera of Blattidæ assumes relatively enormous proportions. In the genus *Hemithyrlocera* (text-fig. 42) this area has increased in size and is conspicuous enough to have attracted the attention of systematists, ever on the look out for characters diagnostic of the difficult genera of the subfamily Pseudomopinae. The area is now known as the triangular apical area, or more



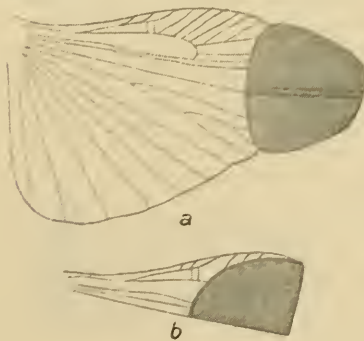
simply, the apical triangle. In the genera *Ectobius*, *Theganopteryx*, and *Chorisoneura*, to select but three examples from many, the apical triangle is still larger, has clearly defined boundaries, and in the closed wing appears either rolled up in a

Text-fig. 43.

*Chorisoneura taeniata* Sauss. & Z.

Wing expanded (*a*) and folded (*b*). The apical triangle is shaded.

Text-fig. 44.

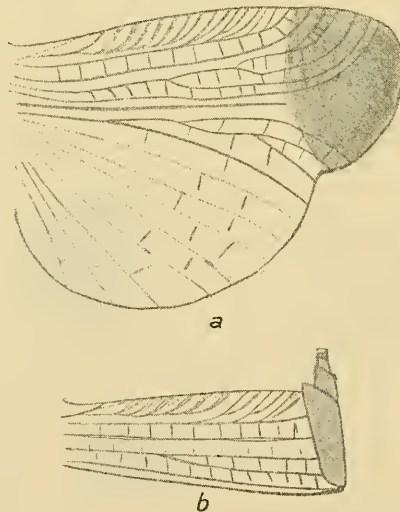
*Anaplecta decipiens* Sauss. & Z.

Wing expanded (*a*) and folded (*b*). The apical area is shaded.

spiral (*Ectobius* and *Theganopteryx*) or as a doubled fold (*Chorisoneura*), lying on the top of the anterior part of the wing (text-fig. 43). Between this stage of wing-development and that

of the genera *Anaplecta* and *Plectoptera* there is every grade of transition. In a typical species of *Anaplecta* the apical triangle has become a large parabolic area, now known as the apical area, almost equal in size to the rest of the wing, over which it is doubled back when the wing is folded (text-fig. 44). In the species *Anaplecta variipennis* Shelf., the passage from an apical triangle to an apical area can be traced; for some individuals exhibit the *Chorisoneura* type of wing-structure; in others is seen the extension of the apical triangle by the widening out of the angle made by the intercalation of this area between the anterior and posterior parts of the wing; finally, some specimens exhibit the complete development of the apical area, with its straight base-line, cutting the wing transversely into two halves, so that the longitudinal veins of the anterior part of the wing and the first axillary veins of the posterior part, no longer impinge on the outer margin of the wing, but on the base-line of the apical area. The summit of wing-development is attained by *Diptoptera dytisoides* Serv., for in this species the apical area is closely veined, though the veins are not in organic continuity with those of the other part of the wing.

Text-fig. 45.

*Prosoplecta nigrovariegata*.

Wing expanded (a) and folded (b). The pseudapical area is shaded.

A cursory glance at the closed wing of any species of *Prosoplecta* (text-fig. 45) leads the observer to suppose that it is constructed on the same principle as that of *Ectobius* and *Thegan-*

*opteryx*, for there is visible a large curled-up spiral lying on the dorsal face of the anterior part of the wing. But when the wing is spread out it is seen that the method of wing-folding is quite peculiar. The triangular apical area though large is not sharply defined as in *Chorisoneura*, *Theganopteryx*, etc., and the spiral fold involves not only this area but also the apical portion of the anterior part of the wing, and a minute portion of the apex of the posterior part. The part of the wing involved in the spiral fold constitutes in fact a *pseud-apical area*, and it is suffused with a dark fuscous colour, just as the true apical area of *Anaplecta* and the apical triangle of *Chorisoneura* etc. are coloured more deeply than the other parts of the wing.

There can be little doubt that this type of wing-folding, unique amongst the Blattidæ, is a modification brought about by the mimetic resemblance, and it is certainly a very singular one. The student of the mimetic resemblances which exist between insects not genetically related, frequently comes across remarkable modifications of structure, modifications which are alien, so to speak, to the constitution of the insects; here a concentration of pilosity to form a false spine, there a patch of colour, a shortening of elytra, or a thickening of legs or antennæ. But invariably he will find these are modifications of structure absolutely essential to the success and perfection of the mimicry; if he looks deeper he will find that mimicry has not touched parts which are concealed, and which therefore play no part in the mimetic resemblance. In short, mimicry is essentially a superficial likeness between organisms fundamentally different. Yet here in the species of *Prosoplecta* we have an exception to this very general rule. The wing of the cockroach does not mimic the wing of the beetle, but it has been modified because of the mimicry between the two orders of insects, or in other words, in this case mimicry *has* affected structures which play no part in a mimetic resemblance. To speak in the crudest of metaphors, it appears as if in the production of these Coccinelliform cockroaches Nature had been in a tremendous hurry. The immediate ancestors of *Prosoplecta* were probably narrow and moderately elongate cockroaches with wings of the *Hemithysocera* type; passage from this form to a short convex form might have proceeded along at least two lines—either the wings might have become gradually shorter *pari passu* with the tegmina, as in certain species of *Ceratinoptera*, *Allacta*, etc., or the wings could have been adapted to an ovate, abbreviated body-form by passing through a *Chorisoneura*-like stage to the *Anaplecta* type. As a matter of fact the evolution of *Prosoplecta* did not travel along either of these lines,—the necessary shortening of the wing when in repose has been produced by a rolling up of as much of the wing as was necessary for the purpose, quite independently of the boundaries between the intercalated apical triangle and the rest of the wing, and so in defiance of the rule observed in all other species of the family.

The geographical distribution of *Prosoplecta* is as follows:— Eight of the species are found in the Philippine Islands, one in Celebes, the remaining three in Batchian and Ceram. None has yet been discovered in the Great Sunda Islands, so that the distribution is discontinuous and serves to emphasize the view that if the Philippines are to be regarded as a part of the Indo-Malayan region, their separation from adjacent land is of very great antiquity. The Philippine Islands constitute an area in which insect mimicry has attained great perfection. That is shown not only by these wonderful cockroaches mimicking Coleoptera, but Professor Poulton tells me that some of the most wonderful examples of mimicry amongst butterflies are known from these islands only, *e.g.* the distasteful Danaine genus *Hestia* is mimicked very closely by a Satyrine and an Elymnine. Again, the gorgeous little Curculionidæ of the genus *Pachyrhynchus* are mimicked by other weevils, by Longicorns, by Cetoniids, and by a cricket\*. A comparative study of mimetic insects in geographically adjacent but zoologically distinct areas, such as Borneo, the Philippines, and Celebes, is a piece of research that would surely yield some very interesting results.

I now give a synoptical key to the genus *Prosoplecta* with descriptions of all the species known to me. It will be observed that I have not always been able to pair a species of *Prosoplecta* with a definite Coleopterous model, but I am pretty confident that these models will eventually be found. I have not had access to comprehensive collections of Philippine Coleoptera, and so it is chiefly the Philippine *Prosoplectæ* which for the present I am not able to match. It is unfortunate that Semper's collection of Philippine Coleoptera is broken up and dispersed; Stål purchased his Orthoptera for the Stockholm Museum, and here it was that I found four new species of *Prosoplecta*, but the Coleoptera captured at or about the same time and in the same districts, I have not been able to trace.

#### *Key to the Species of Prosoplecta.*

- |                                                                                                    |                             |
|----------------------------------------------------------------------------------------------------|-----------------------------|
| 1. Less convex species. Tegmina with a smooth flattened tubercle near the middle of the anal vein. |                             |
| 2. Pronotum piceous, margined all round with hyaline testaceous .....                              | <i>P. coccinella</i> Sauss. |
| 2'. Pronotum bright rufous .....                                                                   | <i>P. bipunctata</i> Br.    |
| 1'. Very convex species. Tegmina without flattened tubercles.                                      |                             |
| 2. Ground colour of tegmina ochreous or rufous.                                                    |                             |
| 3. Tegmina maculate.                                                                               |                             |
| 4. Maculæ of tegmina piceous.                                                                      |                             |
| 5. Tegmina deeply punctate. (Pronotum with 4 maculæ.) .....                                        | <i>P. trifaria</i> Walk.    |

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\* Semper in his 'Animal Life,' p. 390 (International Scientific Series, 1890) gives figures of some of these mimetic insects, amongst them one with the legend "Phoraspis (grasshopper) mimics a Coccinella." This is an error, for the Phoraspis is a cockroach, apparently identical with *Prosoplecta ligata* Br. The species described below as *P. semperi* is a much better mimic of the Coccinellid figured by Semper than is *P. ligata*. Semper's figures (and error) are reproduced by Dr. Wallace in his 'Darwinism.'



- 5'. Tegmina not deeply punctate.  
 6. Ground colour of tegmina ochreous ..... *P. nigroplagiata*, sp. n.  
 6'. Ground colour of tegmina rufous ..... *P. semperi*, sp. n.  
 4'. Maculae of tegmina ochreous ..... *P. rufa* Kirby.  
 3'. Tegmina immaculate, margined with piceous . *P. ligata* Br.  
 2'. Ground-colour of tegmina piceous or dark castaneous.  
 3. Tegmina with not more than 4 rufous or ochreous maculae.  
 4. Tegmina distinctly punctate ..... *P. quadriplagiata* Walk.  
 4'. Tegmina indistinctly punctate ..... *P. nigra*, sp. n.  
 3'. Tegmina with more than 4 rufous or ochreous maculae.  
 4. Pronotum ochreous with 5 piceous maculae . *P. gutticollis* Walk.  
 4'. Pronotum piceous with the lateral margins hyaline ochreous.  
 5. Maculae on tegmina ochreous, more or less circular ..... *P. mimas*, sp. n.  
 5'. Maculae on tegmina rufous, more or less band-like ..... *P. calophoroides*, sp. n.

PROSOPLECTA COCCINELLA Sauss. (Pl. XLVIII. fig. 5.)

*Prosoplecta coccinella* Saussure, Rev. Zool. (2) xvi. p. 324 (1864); Mém. Mexique, Blatt. p. 173 (1864).

♀. Head castaneous, vertex paler. Antennæ castaneous at base, remainder fuscous. Pronotum transversely elliptical, with the disc piceous, punctate, all the margins testaceo-hyaline. Tegmina dark castaneous, seriate-punctate; mediastinal area testaceo-hyaline; a minute, smooth, flattened tubercle at the humeral angle, a smaller one near the base of the radial vein and a larger one in the centre of the disc near the middle of the obsolete anal vein, testaceous. Wings infuscated, veins castaneous. Abdomen above fuscous, supra-anal lamina margined with testaceous, sub-bilobate; abdomen beneath piceous, nitid, sub-genital lamina very large, semiorbicular. Cerci short. Legs castaneous.

Total length 8-9 mm.; length of tegmina 6.2 mm.; pronotum 2.5 mm. × 3.5 mm.

PHILIPPINE IS. (Paris Mus., *type*; British Mus.; Oxford Mus.).

The species is not coccinelliform, but is more like a little Chrysomelid.

PROSOPLECTA BIPUNCTATA Br. (Pl. XLVIII. fig. 2.)

*Areolaria bipunctata* Brunner von Wattenwyl, Nouv. Syst. Blatt. p. 261 (1865).

♀. Very similar to the preceding species, but the head is bright rufous, the palpi and the bases of the antennæ are piceous, remainder of antennæ clear testaceous. Pronotum rufous, lateral margins testaceo-hyaline, posterior margin opaque testaceous, with a fuscous line at the posterior angle. Tegmina piceous with mediastinal area testaceous, a flattened smooth tubercle, testaceous in colour, in the same position as the largest one in *P. coccinella*. Abdomen piceous above and beneath, faintly margined with testaceous. Coxæ and femora rufous, tibiæ and tarsi castaneous.

Total length 8.5 mm.; length of tegmina 6.5 mm.; pronotum 2 mm.  $\times$  3.5 mm.

PHILIPPINE Is. (Stettin Mus., *type*; Stockholm Mus., *coll. Semper*).

This species is also like a Chrysomelid.

PROSOPLECTA TRIFARIA Walk. (Pl. XLVIII. figs. 4 & 11.)

*Prosoplecta trifaria* Walker, Cat. Blatt. Brit. Mus. p. 190 (1868) [= ♂].

*Prosoplecta megaspila* Walker, l. c. (1868) [= ♀].

Very convex, bright ochreous with piceous maculae on pronotum and tegmina.

♂. Head and antennae ochreous, a blotch on the frons, the labrum and apices of maxillary palpi, fuscous. Pronotum nitid, impunctate, transversely elliptical, with four small piceous maculae on the disc. Tegmina seriate-punctate, a line between the bases of the radial and mediastinal veins, a short line above the humeral angle (which is pronounced), the inner margin of the left tegmen at the base, the portion of the right tegmen overlapped by the left and a round macula in the anal field, piceous. Wings infuscated. Abdomen above and beneath and the legs ochreous. Sub-genital lamina symmetrical with a median plication, posteriorly emarginate, styles minute. Cerci moderate.

♀. Similar, but the piceous markings on the tegmina heavier, and a large additional macula on the discoidal field beyond the middle. The abdomen beneath is castaneous, and the sub-genital lamina is very large and semiorbicular.

Total length (♂) 9 mm., (♀) 9.5 mm.; length of tegmina (♂) 7.5 mm., (♀) 8.1 mm.; pronotum 3 mm.  $\times$  4 mm.

BATCHIAN (Oxford Mus., *types, coll. Wallace*).

The male is an admirable mimic of *Oides biplagiata*, and the female resembles a dark variety of the same insect (Chrysomelidae, subfam. Galerucinae). (Pl. XLVIII. figs. 3 & 10.)

PROSOPLECTA NIGROPLAGIATA, sp. n. (Pl. XLVIII. fig. 9.)

♀. Allied to *P. trifaria*, but distinguished by the obsolescent puncturation of the tegmina. Head rufous, vertex ochreous. Antennae very slender, ochreous, with the apex infuscated. Pronotum ochreous, smooth, nitid, transversely elliptic, lateral margins hyaline, eight piceous maculae arranged in a circle on the disc, the anterior pair almost fused, one pair minute. Tegmina ochreous, extreme base of mediastinal area hyaline, a macula at the base of the mediastinal area, a macula at the apex of the same area, a line joining these, a round macula on the middle of the anal vein, a curved line running from this over the humeral angle to the base of the tegmen, where there is another spot, the basal margin, a short line along the base of the sutural margin of the right tegmen, a large macula in the discoidal field beyond the middle, all piceous. Wings infuscated. Abdomen beneath rufo-castaneous, sub-genital lamina very large, semiorbicular. Cerci and legs rufous.

Total length 9.5 mm.; length of tegmina 7.9 mm.; pronotum 3 mm. × 5 mm.

PHILIPPINE IS. (Stockholm Mus., *type, coll. Semper*).

This species is a good mimic of *Prioptera sinuata* Oliv. (Cassididæ), and it is highly probable that a Coccinellid and perhaps a Chrysomelid also enter into mimetic relationship with these forms. (Pl. XLVIII. fig. 8.)

PROSOPECTA SEMPERI, sp. n. (Pl. XLVIII. fig. 13.)

♀. Differs from *P. nigroplagiata* in the following details:—Size larger and broader; the general ground colour is rufous; there are only six maculæ on the disc of the pronotum, the anterior pair being suppressed; on the tegmina there are no lines joining any of the maculæ, the maculæ are as in *nigroplagiata*; there is an ellipsoidal piceous marking on the part of the right tegmen overlapped by the left; the disc of the subgenital lamina is suffused with castaneous.

Total length 10.5 mm.; length of tegmina 7.8 mm.; pronotum 3 mm. × 5.8 mm.

PHILIPPINE IS. (Stockholm Mus., *type, coll. Semper*).

Mimics *Leis dunlopi* Crotch (Coccinellidæ). (Pl. XLVIII. fig. 12.)

PROSOPECTA LIGATA Br.

*Cassidodes ligata* Brunner von Wattenwyl, Nouv. Syst. Blatt. p. 262, pl. vi. fig. 28 (1865).

The species is known to me only from the description, which it is unnecessary to reproduce, since it occurs in the vade-mecum of all students of the Blattidæ.

PHILIPPINE IS. (Stettin Mus., *type*).

PROSOPECTA RUFA Kirby\*. (Pl. XLVIII. fig. 16.)

*Prosopecta rufa* Kirby, Ann. Mag. Nat. Hist. (7) xii. p. 379 (1903).

This species is known to me only from the description, which I transcribe:—

“Long. corp. cum tegm. 9 millim.; lat. 5 millim.

“*Female*.—Light red, the tegmina somewhat darker. Pronotum smooth and shining, with the front border narrower than the hind border, transversely oval, with broad borders of subhyaline yellow covering the rounded off lateral angles, and the hind border yellow. Tegmina with the costal margin subhyaline yellow, a small yellow spot near the base, and another at one third of the length, both near the costa; between the second and the inner margin is a much larger, transverse, oval, yellow spot. Base of tegmina blackish. Wings, and a great portion of the middle of the abdomen beneath, as far as the base of the terminal segment, black.”

PHILIPPINE ISLANDS, Mindanao (British Mus., *type*).

\* It is probable that *P. rufa* is identical with *P. bipunctata*, a discovery made long after this paper was in the press. The extreme difficulty under which the paper was written must be my excuse.

PROSOPECTA QUADRIPLAGIATA Walk. (Pl. XLVIII. fig. 14.)

*Prosoplecta quadriplagiata* Walker, Cat. Blatt. Brit. Mus. p. 189 (1868).

♂. Head castaneous, antennæ rufo-testaceous. Pronotum piceous, smooth, nitid. Tegmina seriate-punctate, piceous, an orange-rufous macula at the base, another in the centre of the discoidal field. Wings fuscous. Abdomen above and beneath rufous; supra-anal lamina transverse, carinate, apex emarginate; sub-genital lamina as in *P. trifaria*. Cerci and legs rufous.

Total length 9.5 mm.; length of tegmina 8 mm.; pronotum 2.8 mm. × 4.5 mm.

BATCHIAN (Oxford Mus., *type, coll. Wallace*).

Somewhat resembles an Erotylid of the genus *Aulacoeilus* or *Cyrtomorphus*.

PROSOPECTA NIGRA, sp. n. (Pl. XLVIII. fig. 6.)

♂. Head rufo-testaceous, antennæ testaceous. Pronotum castaneous, impunctate, nitid, faintly striate transversely in the middle of the anterior half. Tegmina very faintly punctate, piceous, an orange rufous macula at the apex. Wings infuscated. Abdomen above and beneath rufous; supra-anal lamina transverse; sub-genital lamina as in the preceding species. Cerci and legs rufous.

Total length 9 mm.; length of tegmina 7.8 mm.; pronotum 2.9 mm. × 4.2 mm.

PHILIPPINE IS. (Stockholm Mus., *type, coll. Semper*).

The species is closely allied to *P. ligata* Br., and is probably a mimic of some Chrysomelid beetle.

PROSOPECTA GUTTICOLLIS Walk. (Pl. XLVIII. fig. 7.)

*Prosoplecta gutticollis* Walker, Cat. Blatt. Brit. Mus. p. 189 (1868).

♀. Head rufo-castaneous, paler on the vertex; antennæ testaceous, fuscous towards apex. Pronotum smooth, nitid, ochreous, lateral margins subhyaline, five piceous maculae on the disc. Tegmina seriate-punctate, piceous, with the following large ochreous maculae on each tegmen:—one in the mediastinal area, one in the middle of the marginal area, one at the base of the tegmen almost divided into two by a short piceous line on the humeral angle, and at its lower interior extremity just touching a macula in the middle of the discoidal field, a fifth macula near the apex of the tegmina. Abdomen above ochreous; supra-anal lamina triangular, cucullate, apex not emarginate. Abdomen beneath piceous, castaneous at base; sub-genital lamina semiorbicular, ample. Cerci and legs rufous.

Total length 9.5 mm.; length of tegmina 8.5 mm.; pronotum 3.1 mm. × 5 mm.

CERAM (Oxford Mus., *type, coll. Wallace*).

Very like a Coccinellid.



## PROSOPLECTA MIMAS, sp. n. (Pl. XLVIII. fig. 15.)

♂. Head rufous, vertex paler; antennæ testaceous, infuscated towards apex. Pronotum smooth, nitid, piceous, lateral margins broadly hyaline, a large ochreous macula at the posterior angles, enclosing three minute piceous spots, a minute V-shaped ochreous mark in the middle near the posterior margin. Tegmina minutely seriate-punctate, piceous, with the following ochreous maculae on each tegmen:—one in the mediastinal area, one in the anal area extending on to the humeral angle, one in the middle of the discoidal field, one outside this and touching the radial vein, one at the apex, that on the left tegmen being larger than that on the right. Wings infuscated. Abdomen beneath, cerci and legs rufous, subgenital lamina as in the other species of the genus.

♀. Similar to the male but the head and abdomen darker, the macula in the anal field of the tegmina almost divided into two, two maculae at the apex of the left tegmen. Supra-anal and subgenital laminae as in the preceding species.

Total length (♂) 8.9 mm., (♀) 10.9 mm.; length of tegmina (♂) 7 mm., (♀) 9 mm.; pronotum (♂) 2.9 mm. × 4.6 mm., (♀) 3 mm. × 5 mm.

PHILIPPINE IS. (Stockholm Mus., types, coll. *Semper*).

## PROSOPLECTA CELOPHOROIDES, sp. n. (Pl. XLVIII. fig. 19.)

♂. Head castaneous, vertex ochreous; antennæ testaceous, fuscous towards the apex. Pronotum impunctate, nitid, piceous with the lateral margins broadly ochreous. Tegmina seriate-punctate, piceous, with the following rufous maculae on each tegmen:—a small circular one in the mediastinal area, a transverse one extending along the base of the tegmen over the humeral angle to the base of the radial vein, another broadly transverse extending across the middle of the discoidal field from near the sutural margin to the radial vein, a fourth circular in shape, near the apex of the tegmen. Wings infuscated. Abdomen and legs rufous; supra-anal lamina of usual shape.

Total length 9.2 mm.; length of tegmina 8 mm.; pronotum 3 mm. × 4.9 mm.

NORTH CELEBES, Toli-Toli (Oxford Mus., type, *Fruhstorfer*, c coll. *Van de Poll*).

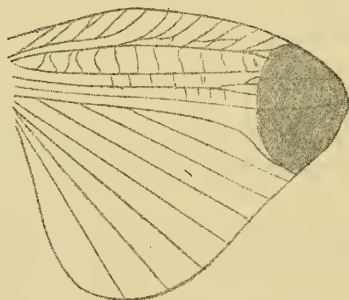
This is an admirably close mimic of the Coccinellid *Celophora formosa* Cr. (Pl. XLVIII. fig. 21), a specimen of which was taken by *Fruhstorfer* in the same locality and at the same time of year. The colouring and arrangement of the maculae on the pronotum and wing-covers of the two insects correspond very closely, but in the beetles there is a transverse basal band on the elytra, whereas in the cockroach the corresponding patch of colour is made up of a band-like spot and an outer circular spot. The mimic is smaller than its model, and that appears to be rather the rule than the exception amongst this group of mimetic couples. *Anisolemnia distaura* Muls. (Pl. XLVIII. fig. 20) is another Coccinellid of nearly the same size and evidently also associated,

*Description of a new Genus and two new Species of Blattidæ.*

## Genus MELYROIDEA, nov.

Head semiglobose, eyes small, far apart, situated on the sides of the head; antennæ with moniliform joints, slightly incrassated, not pilose, third joint twice as long as second. Pronotum quadrate, angles rounded, margins somewhat reflexed, not covering the vertex of the head; disc with slight elevations and depressions. Tegmina densely reticulated, obscuring the venation, semi-corneous in texture, anal field scarcely distinguishable; scutellum exposed. Wings with moderate apical field, which in repose is doubled on itself longitudinally and tightly rolled up, not folded back over the rest of the wing; traces of venation in the lower half of the apical field. Supra-anal lamina of female triangular or trigonal; sub-genital lamina divided by a sulcus; cerci variable. Legs slender, all the femora unarmed, tibiæ very sparsely spined, tarsi without arolia. Male unknown.

Text-fig. 46.

*Melyroidea mimetica.*

Expanded wing. The apical area is shaded.

This is quite one of the most remarkable genera of Blattidæ that has yet been discovered. The two species comprised in it present in their form and coloration a curious resemblance to Malacoderm Coleoptera, whilst in their structural features they appear to be intermediate between the Corydiinæ and Oxyhaloinæ [= Plectopterinae]. The head with its globose front and vertex and widely separated eyes of small size, the cleft sub-genital lamina of the female, and the naked tarsal claws are characteristic features of the Corydiinæ. On the other hand, the wing-structure is totally unlike that of the Corydiinæ, in which subfamily alone amongst the Blattidæ the anterior part of the wing is greatly developed, the posterior part folding beneath not in a fan-like manner. In *Melyroidea* the wing with its prominent apical area and posterior part furnished with radiating veins is

typically Plectopterine in structure, and this character, in conjunction with the fan-like folding of the posterior part of the wing, is overwhelming evidence in favour of the inclusion of the genus in the Oxyhaloinæ [= Plectopterinae].

*MELYROIDEA MIMETICA*, sp. n. (Pl. XLVIII. fig. 17.)

♀. Head bright rufous, last joint of maxillary palpi fuscous, antennæ fuscous, except the basal and last apical joints, which are rufo-testaceous. Pronotum bright rufous, quadrate, anterior and lateral margins slightly reflexed, sides only slightly deflexed; disc with slightly rounded elevations, two anterior, two antero-lateral, and one, the largest, central. Tegmina dark castaneous, densely reticulated, mediastinal vein short, an oblique sulcus on the right tegmen marking the outer limit of the area overlapped by the left tegmen. Wings infuscated, radial vein bifurcated from the base, twelve costal veins, apices not incrassated, median vein simple, medio-discal area crossed by fourteen irregular venulæ, thrice as broad as the medio-ulnar area, which is crossed by eleven venulæ, ulnar vein bifurcate, transverse venulæ connecting it with the dividing vein, first axillary vein triramosæ; apical area about one third of total wing-length, its base obtusely angled, nearly equally divided longitudinally, some obscure venulations in the lower half. Abdomen piceous above and beneath, supra-anal lamina triangularly produced, sub-genital lamina cleft by a sulcus; cerci short, acuminate, rufous. Coxæ, femora, and bases of tibiæ testaceous, rest of tibiæ and the tarsi fuscous; formula of apical spines  $\frac{1}{1}, \frac{0}{0}, \frac{0}{0}$ , genicular spines on mid and hind femora; front tibiæ unarmed except for three apical spines, mid and hind tibiæ with one pair of basal and two apical spines above, with ten spines in a double row and two apical spines below.

Total length 13.5 mm.; length of body 11 mm.; length of tegmina 9.5 mm.; pronotum 4 mm. × 4 mm.; hind femora 4 mm.; hind tibiæ 4 mm.; hind tarsi 3 mm.

*Hab.* Uncertain, but probably near RIO DE JANEIRO.

One example (Miers collection. Oxford Museum).

The species is very like a Telephorid beetle.

*MELYROIDEA MAGNIFICA*, sp. n. (Pl. XLVIII. fig. 18.)

♀. Head bright rufous, maxillary palpi piceous, antennæ piceous, except for three joints beyond the middle, which are testaceous, slightly incrassated in the middle. Pronotum bright rufous, quadrate, very slightly broader anteriorly than posteriorly, all the borders somewhat reflexed, disc with two antero-lateral crescentic depressions. Tegmina green, the humeral angle and the part of the right tegmen overlapped by the left dark shining blue, densely reticulated but the veins elevated, mediastinal vein short, radial vein bifurcated from near the base, six highly irregular and branched costal veins, ulnar vein with three ramose branches, apex of anal vein attaining a point at

more than one third of the sutural margin. Wings very dark fuscous. Abdomen, cerci, and legs dark blue with metallic reflections, supra-anal lamina trigonal, sub-genital lamina cleft and valvular in appearance; cerci very long, with sparse erect pubescence, not acuminate. Formula of apical spines  $\frac{1}{0}, \frac{0}{0}, \frac{0}{0}$ , no genicular spine on front femora; front tibiae with three apical spines and one spine beneath, mid and hind tibiae with two widely separated spines above, four apical spines and a double row of spines beneath.

Total length 14 mm.; length of body 11 mm.; length of tegmina 11.5 mm.; pronotum 2.8 mm.  $\times$  3 mm.

ECUADOR.

One example (Saunders collection, Oxford Museum).

This gorgeous little cockroach is also very like a Telephorid, but I have not been able to match it with any particular species.

In the preparation of this paper I have been much indebted to the kind assistance of my friend, Mr. G. J. Arrow, who has diligently searched the rich collections of Coleoptera in the British Museum for models to some of the remarkable mimetic cockroaches described above. Mr. Arrow has also supervised the preparation of the plate accompanying this paper.

#### EXPLANATION OF PLATE XLVIII.

Fig. 1. *Megapyga eximia* Boh.

2. *Prosoplecta bipunctata* Br.

3. *Oides biplagiata* Jac.

4. *Prosoplecta trifaria* Walk., ♂.

5. *P. coccinella* Sauss.

6. *P. nigra*, sp. n.

7. *P. gutticollis* Walk.

8. *Prioptera sinuata* Oliv.

9. *Prosoplecta nigroplagiata*, sp. n.

10. *Oides biplagiata* Jac., var.

11. *Prosoplecta trifaria* Walk., ♀.

Fig. 12. *Leis dunlopi* Crotch.

13. *Prosoplecta semperi*, sp. n.

14. *P. quadriplagiata* Walk.

15. *P. mimas*, sp. n.

16. *P. rufa* Kirby.

17. *Melyroidea mimetica*, sp. n.

18. *M. magnifica*, sp. n.

19. *Prosoplecta cælophoroides*, sp. n.

20. *Anisolemnia distaura* Muls.

21. *Cælophora formosa* Crotch.

## 20. On the Pairing of Pseudoscorpiones.

By H. WALLIS KEW, F.Z.S.

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(Text-figures 47-50.)

### I. Introduction.

The breeding habits of Arachnida are of special interest from the fact that in no other Class do we find so great a diversity of method\*. Much attention has been paid to the subject, and the main facts are established for most of the Orders. For Pseudoscorpiones, however, scarcely anything is known.

Rösel von Rosenhof, so long ago as 1755 (1), tells us that he kept these animals together for a long time in the hope of seeing

\* Cf. Pocock (19), p. 2.